

1           1. A spinal fixation apparatus comprising:  
2                 a longitudinal rod;  
3                 a plurality of stem clamps mounted to said longitudinal  
4                 rod, each of said stem clamps comprising a clamp body having  
5                 a stem extending outwardly therefrom and an upper jaw and a  
6                 lower jaw, said upper jaw being resiliently joined to said  
7                 lower jaw through a cylindrical sidewall, said cylindrical  
8                 sidewall forming one portion of a lateral throughbore through  
9                 said clamp body for slidably receiving said longitudinal rod  
10                in clamping relationship, said clamp body including a  
11                transverse throughbore passing through said upper jaw and said  
12                lower jaw, the portion of said transverse throughbore through  
13                said lower jaw having threads therein, said stem clamp  
14                including a bolt for passing through said transverse  
15                throughbore and threadedly engaging said threads in said lower  
16                jaw thereby compressing said upper jaw toward said lower jaw  
17                to securely anchor said stem clamp to said longitudinal rod;  
18                 a plurality of C-clamps mounted to said stems and to said  
19                 longitudinal rod, each of said C-clamps including a clamp body  
20                 having an upper jaw and a lower jaw resiliently connected to  
21                 said upper jaw through a cylindrical sidewall, said  
22                 cylindrical sidewall forming a lateral throughbore through  
23                 said clamp body for selectively receiving said longitudinal  
24                 rod and said stems, said clamp body including a transverse  
25                 throughbore through said upper jaw and said lower jaw, said  
26                 transverse throughbore including threads in said lower jaw; and

1                   a bone screw for selectively securing said C-clamp to  
2                   said longitudinal rod and said stem, said bone screw also  
3                   mounting said C-clamp to bone, said bone screw having an  
4                   elongated screw body and a screw head, said screw body having  
5                   a distal end and a proximal end with said proximal end being  
6                   adjacent said screw head, said screw body having a reduced  
7                   diameter from said distal end to a diametrically enlarged  
8                   shoulder adjacent said screw head, said reduced diameter  
9                   passing through said transverse throughbore in said C-clamp in  
10                  a nonbinding relationship, said screw body having a first set  
11                  of threads with said diametrically enlarged shoulder having a  
12                  second set of threads, said second set of threads being  
13                  configured to threadedly engage said threads in said lower jaw  
14                  of said C-clamp.

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16                 2. The spinal fixation apparatus defined in claim 1 wherein  
17                 said bone screw includes said first set of threads and said second  
18                 set of threads having an identical thread pitch.

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20                 3. The spinal fixation apparatus defined in claim 2 wherein  
21                 said threads have an angled face toward said distal end and an  
22                 orthogonally oriented face toward said proximal end.

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1           4. The spinal fixation apparatus defined in claim 1 wherein  
2         said spinal fixation apparatus includes a second longitudinal rod  
3         spaced from said longitudinal rod and with a second plurality of  
4         said stem clamps mounted to said second longitudinal rod, a second  
5         plurality of said C-clamps mounted to said stems of said second  
6         plurality of said stem clamps, and a second plurality of said bone  
7         screws mounting said C-clamps to the bone.

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9           5. The spinal fixation apparatus defined in claim 4 wherein  
10        said spinal fixation apparatus includes a cross-link plate mounted  
11        between said longitudinal rod and said second longitudinal rod,  
12        said cross-link plate having a first end and a second end with a  
13        first eyelet formed in said first end and a second eyelet formed in  
14        said second end, said cross-link plate having a shank extending  
15        between said first eyelet and said second eyelet, said shank having  
16        a square profile at the midsection of said shank.

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18           6. The spinal fixation apparatus defined in claim 1 wherein  
19        said C-clamp includes an angular offset of said lower jaw from said  
20        upper jaw, said angular offset having an angle within the range on  
21        the order of about one degree to ten degrees.

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23           7. The spinal fixation apparatus defined in claim 1 wherein  
24        said C-clamp includes a detent means as an engagement means on said  
25        C-clamp.

1           8. The spinal fixation apparatus defined in claim 1 wherein  
2        said stem clamp includes an angular offset of said lower jaw from  
3        said upper jaw, said angular offset having an angle within the  
4       range on the order of about one degree to ten degrees.

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6           9. The spinal fixation apparatus defined in claim 1 wherein  
7        said longitudinal rod includes a right angle bend formed in said  
8       longitudinal rod.

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10          10. The spinal fixation apparatus defined in claim 1 wherein  
11        said stem on said stem clamp is of the same diameter as said  
12       longitudinal rod.

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14          11. The spinal fixation apparatus defined in claim 1 wherein  
15        said C-clamp includes a bone pin for temporarily mounting said  
16       spinal fixation apparatus to the spine prior to inserting said bone  
17       screws into the spine.

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19          12. The spinal fixation apparatus defined in claim 11 wherein  
20        said bone pin comprises a handle segment for hand grasping said  
21       bone pin and a pin segment for insertion through said C-clamp and  
22       into the bone of the spine, said bone pin thereby releasably  
23       mounting said C-clamp to the spine.

1       13. A spinal fixation apparatus for implantation on a spine  
2 comprising:

3              a first longitudinal rod for placement on the spine at  
4 one side of and generally parallel to the spinous process of  
5 the spine;

6              a second longitudinal rod for placement on the spine at  
7 the other side of and generally parallel to the spinous  
8 process of the spine;

9              a plurality of stem clamps mounted to said first  
10 longitudinal rod and said second longitudinal rod;

11             a plurality of C-clamps mounted to said stem clamps and  
12 to said first longitudinal rod and to said second longitudinal  
13 rod;

14             a plurality of bone screws mounted to said C-clamps, said  
15 bone screws securing said C-clamps to the spine; and

16             at least one cross-link plate interconnecting said first  
17 longitudinal rod to said second longitudinal rod.  
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19        14. The spinal fixation apparatus defined in claim 13 wherein  
20 each of said first longitudinal rod and said second longitudinal  
21 rod includes a right angle bend.  
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1        15. The spinal fixation apparatus defined in claim 13 wherein  
2        said stem clamp comprises a clamp body having an upper jaw and a  
3        lower jaw with a lateral throughbore passing between one edge of  
4        said clamp body, said throughbore telescopically receiving said  
5        first to second longitudinal rods, said clamp body including a  
6        transverse throughbore passing orthogonally through said upper jaw  
7        and said lower jaw with the portion of said transverse throughbore  
8        through said lower jaw having threads therein, said clamp body  
9        including a stem extending orthogonally therefrom, said stem clamp  
10      including a bolt means for threadedly engaging said threads to  
11      bring said upper jaw toward said lower jaw and constrict said  
12      lateral throughbore thereby securing said stem clamp to said  
13      longitudinal rod.

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15        16. The spinal fixation apparatus defined in claim 13 wherein  
16        said C-clamp comprises a clamp body having an upper jaw and a lower  
17        jaw with a lateral throughbore passing between said upper jaw and  
18        said lower jaw, said clamp body having a transverse throughbore  
19        passing orthogonally through said upper jaw and said lower jaw with  
20        the portion of said transverse throughbore in said lower jaw having  
21        threads therein.

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17. The spinal fixation apparatus defined in claim 16 wherein said C-clamp includes engagement means for engaging said C-clamp with said bone screw, said bone screw comprising a bolt head at a proximal end and a tip at a distal end, said bone screw having a threaded shaft between said proximal end and said distal end with said threaded shaft having a threaded, diametrically enlarged shoulder adjacent said bolt head and a threaded, diametrically reduced screw body between said shoulder and said tip, the thread pitch for said threaded, diametrically enlarged shoulder being identical to said threaded, diametrically reduced screw body, said threaded, diametrically enlarged shoulder threadedly engaging said threads in ~~said transverse throughbore~~ in said lower jaw of said C-clamp thereby providing said engagement means for said C-clamp.

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18. The spinal fixation apparatus defined in claim 17 wherein said upper jaw includes an angular offset from said lower jaw to accommodate being compressed downwardly upon tightening with said bone screw, said angular offset comprising an angle within the range on the order of about one degree to ten degrees.

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19. The spinal fixation apparatus defined in claim 13 wherein said stem clamp includes a lower jaw and an upper jaw, said lower jaw having an angular offset from said upper jaw, said angular offset being within the range on the order of about one to ten degrees.

1           20. The spinal fixation apparatus defined in claim 13 wherein  
2        said bone screw comprises a screw having a head at a proximal end  
3        and a tip at a distal end, said screw having a diametrically enlarged  
4        shoulder adjacent said head, said shoulder having a first set of  
5        threads, said screw including a shaft extending between said  
6        shoulder and said tip, said shaft being diametrically smaller than  
7        said shoulder and having a second set of threads, said second set  
8        of threads having the same thread pitch as said first set of  
9        threads.

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11           21. The spinal fixation apparatus defined in claim 20 wherein  
12        said second set of threads includes a thread profile having a  
13        planar face orthogonal to the axis of said shaft, said planar face  
14        being oriented toward said head.

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16           22. The spinal fixation apparatus defined in claim 13 wherein  
17        said C-clamp includes a bone pin for temporarily mounting said C-  
18        clamp to the spine prior to inserting said bone screw, said bone  
19        pin having a handle and a pin extending therefrom, said pin having  
20        a reduced diameter to pass through said C-clamp and into the bone.

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1      23    A method for providing fixation of a spine comprising the  
2      steps of:

3                obtaining a longitudinal rod;

4                preparing a plurality of stem clamps with stems extending  
5      therefrom;

6                mounting said stem clamps to said longitudinal rod;

7                fabricating a plurality of C-clamps;

8                affixing said C-clamps to said longitudinal rod and to  
9      said stems of said stem clamps;

10               forming a plurality of bone screws;

11               securing said C-clamps to a spine with said bone screws;

12               and

13               tightening said stem clamps and said C-clamps thereby  
14               providing spinal fixation with said longitudinal rod.

16               24. The method defined in claim 23 wherein said fabricating  
17      step comprises preparing said C-clamp as a pair of opposed jaws  
18      having a lateral throughbore therethrough for slideably receiving  
19      said longitudinal rod or said stem of said stem clamp, said  
20      preparing step including forming a transverse throughbore through  
21      said upper jaw and said lower jaw and creating a set of threads in  
22      the lower jaw portion of said transverse throughbore.

1        25. The method defined in claim 23 wherein said fabricating  
2        step includes forming said plurality of bone screws with a first  
3        threaded section and a second threaded section, said first threaded  
4        section having a smaller diameter sufficient to pass through said  
5        transverse throughbore in said C-clamp, said second threaded  
6        section threadedly engaging said set of threads in said C-clamp  
7        thereby selectively clamping said C-clamp to said longitudinal rod  
8        and said stem.

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10      26. The method defined in claim 23 wherein said obtaining  
11     step includes providing a second longitudinal rod and affixing said  
12     second longitudinal rod to the spine along with said longitudinal  
13     rod using said stem clamps, said C-clamps, and said bone screws.

14      ~~25~~      27. The method defined in claim ~~26~~ wherein said providing  
15     step includes coupling said longitudinal rod to said second  
16     longitudinal rod with a cross-link plate.

17      ~~24~~      28. The method defined in claim ~~27~~ wherein said coupling step  
18     includes forming said cross-link plate with a first end and a  
19     second end and a first eyelet in said first end and a second eyelet  
20     at said second end, said forming step including providing a shank  
21     between said first eyelet and said second eyelet, said providing  
22     step including forming said shank with a square cross-sectional  
23     profile thereby deformably adjusting said cross-link plate to said  
24     longitudinal rod and said second longitudinal rod.  
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1           29. The method defined in claim 23 wherein said forming step  
2 includes preparing threads on said bone screw for securely engaging  
3 bone with said threads, said preparing step including shaping said  
4 threads with a generally flat surface orthogonal to the axis of  
5 said bone screw, said flat surface being oriented to the outer  
6 surface of the bone as said bone screw is inserted into the bone.

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8           30. The method defined in claim 23 wherein said affixing step  
9 includes obtaining a plurality of bone pins and ascertaining the  
10 placement of said longitudinal rod, said stem clamps, and said C-  
11 clamps prior to said securing step by mounting said C-clamps to the  
12 spine with said bone pins.

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